ISLAND COUNTY 2003 MOSQUITO SURVEY REPORT

Prepared for:
Island County Health Department

Prepared by:
Robert M. Stansbury

January 2004

TABLE OF CONTENTS

TABLES

FIGURES

PROJECT ORGANIZATION

The Island County Mosquito Surveillance Program was funded through a grant from the National Center for Environmental Health, Centers for Disease Control and Prevention (CDC). The grant was administered by the Island County Health Department and the Environmental Health Section carried out the activities.

Island County Health Department
Environmental Health Section
PO Box 5000
Coupeville, WA 98239
(360) 679-7350

Tim McDonald, R.S., MPH	Health Services Director, Principal Investigator
Keith Higman	Environmental Health Director, Section Supervisor
Robert Stansbury	Project Coordinator
Kathleen Parvin, R.S.	Technical Assistance

Executive Summary

In less than five (5) years West Nile Virus (WNV) has spread from an appearance in New York to afflicting all but three (3) of the contiguous United States, with 8,567 human cases reported to the CDC in 2003. As WNV has become endemic to more states it has spread farther and faster each year and there is a high likelihood it will be detected in Island County in 2004. Island County public health officials need accurate and more current data in order to make an informed and effective response. The 2003 Island County Mosquito Survey project was a response to that need.

The main objective of the project was to identify the mosquito species present in the county and where they are found. Between mid-June and September 30th there were 140 sampling events (i.e. trapping, dipping, etc) distributed over 17 days. Eighteen (18) species were observed during the survey. Five (5) species not previously documented in the county were discovered, two of which are considered potential WNV vectors.

Sample sites were associated with mosquito complaints, human populations and areas potentially breeding and harboring mosquitoes. When choosing sample sites special consideration was given to those considered at highest risk (immunosuppressed patients and people over fifty years of age). This included trapping and dipping in areas surrounding hospitals, retirement communities, and adult care facilities.

There is a slightly higher incidence of *Culiseta inornata* across the central portion of the county, especially on Camano Island. Camano Island also had a higher incidence of *Coquillettidia perturbans* than did Whidbey Island. More *Culex pipiens* were found on Whidbey Island than Camano Island and were predominantly associated with populated areas, i.e. Oak Harbor, Coupeville, Freeland, and Clinton. We will not know which species will transmit WNV in Washington until the virus actually arrives and surveillance results begin to be analyzed. The most likely vectors of concern in 2004 will be those in the *Culex* genus, in particular, *Culex tarsalis* and *Culex pipiens*.

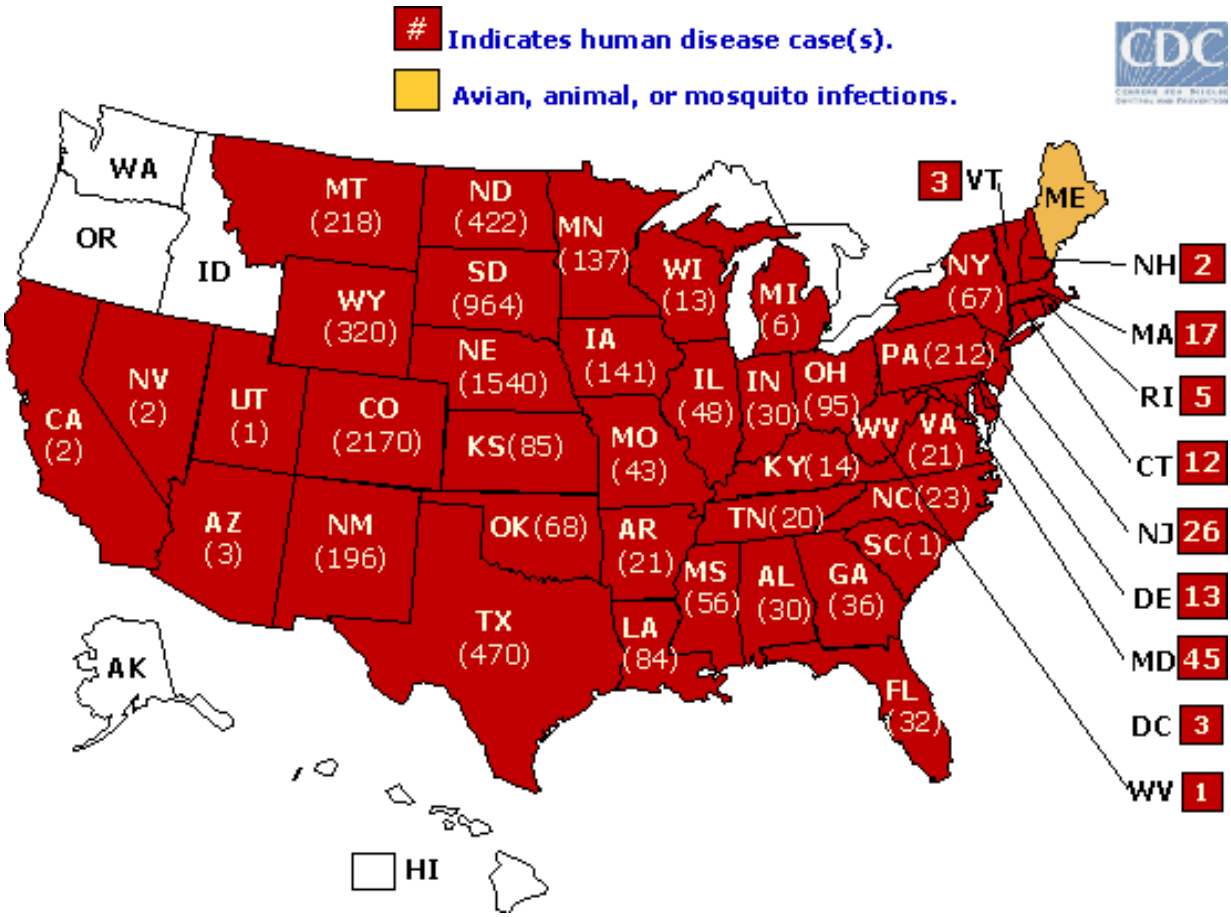
The 2003 mosquito season was anomalous in that it was one of the warmest of record and the driest in over 100 years. Specifically how these drought conditions affected mosquito population dynamics is a matter for speculation but a wetter, more typical season would likely show different survey results.

Introduction

In less than five (5) years West Nile Virus (WNV) has spread from an appearance in New York to afflicting all but three (3) of the contiguous United States, with 8,567 human cases reported to the CDC in 2003 (see Figure 1). As WNV has become endemic to more states it has spread farther and faster each season and, considering the 2003 season, will probably appear in Island County in 2004 (see Figure 2). Accurate and more complete data than previously available is needed by Island County public health officials to make informed and responsible decisions. The 2003 Island County Mosquito Survey project, conducted June through September by Island County Health Department (ICHD), was a response to that need. Five mosquito species not previously observed here were discovered, two of which are considered potential vectors of WNV.

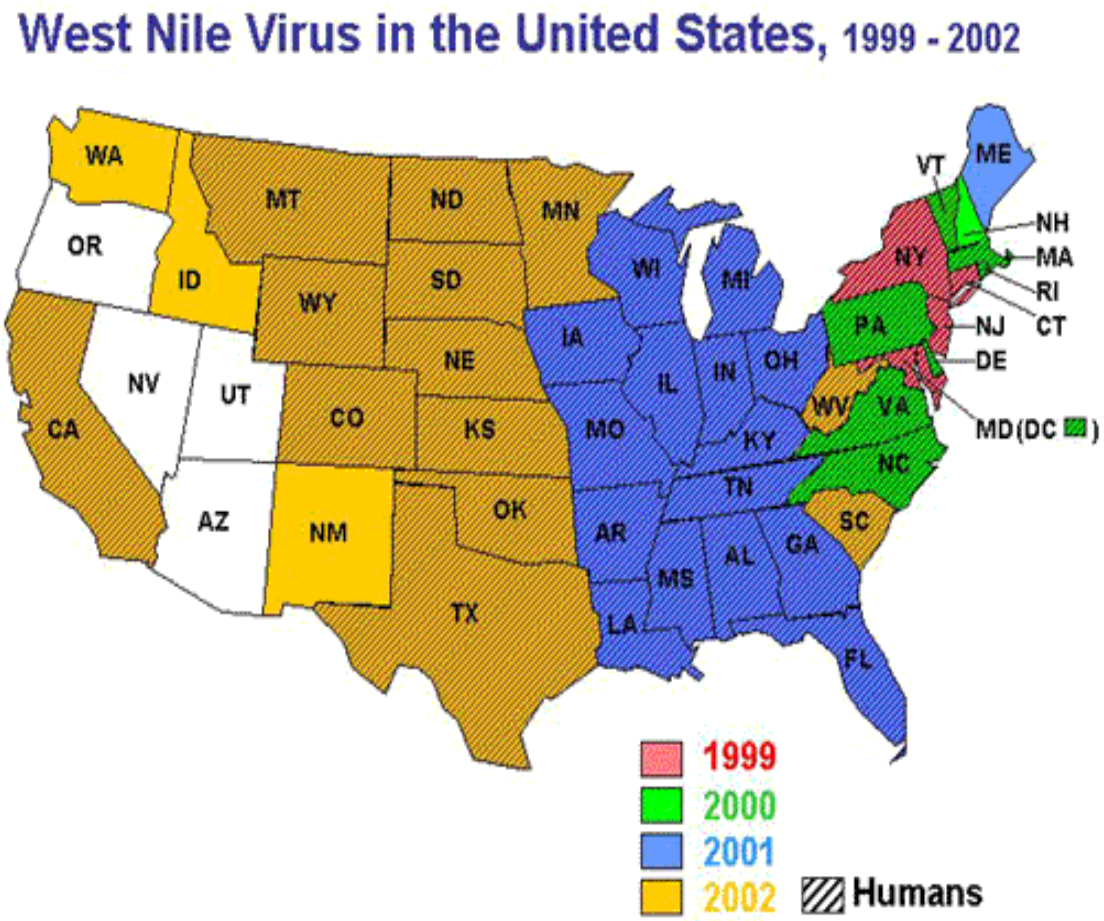
Mosquitoes are generally considered a nuisance but some, notably *Aedes vexans* and *Ochlerotatus dorsalis* (salt marsh mosquito), can become an extreme nuisance. In certain areas of the county they sometimes appear in large numbers and generate many complaint calls. Mosquitoes can be a health issue for certain individuals, causing excessive irritation around the bite area, severe allergic reactions or secondary infections from scratching. Some species, ones that are known to potentially harbor and pass on disease (*vector* species), may pose a potentially more serious public health risk for county residents and visitors. We will not know which species will transmit WNV in Washington until after the virus actually arrives and surveillance results begin to be analyzed.

Figure 1. CDC Map, WNV 2003



In 2003 only three (3) states in the contiguous United States did not have any confirmed cases of WNV. There were over twice as many human cases this year (8,567) as last. Colorado alone had over half as many cases this year as did the entire country in 2002.

Figure 2. CDC Map, WNV 1999-2002



The above map gives a perspective of the historical progress of WNV westward across the United States. Beginning in New York State, WNV spread to five (5) states in 1999. As the virus becomes endemic in more states it spreads sooner, farther and faster, and by 2002 the virus had spread to 44 states with 4156 laboratory confirmed human cases. This included four confirmed animal cases in Washington State (there were no confirmed human cases contracted within the state).

Project Description

The main objective of the project was to identify which mosquito species are present in the county and where they are found. This project was the first attempt at characterizing the mosquito species composition of Island County (a *survey*) and does not show historical variation in habitat or species composition and distribution over time (*surveillance*). The survey was neither exhaustive nor intended to guide specific mosquito control efforts. Information from the survey will be used by citizen groups to help evaluate potential need for mosquito control efforts, by the ICHD for education and potential interventions to protect public health, and to provide a baseline for future surveillance programs.

Standardized collection protocols recommended by Washington State Department of Health (DOH) were used in obtaining both mosquito larvae and adults. Logistic and survey protocols unique to Island County were developed that will enable future surveillance programs to be more effective. Each sample event (dipping, trapping, etc.) was assigned a local identification number (local ID) and the numbered batches of adult mosquitoes obtained from rearing or capture were sent to DOH in Olympia to be officially identified by species and documented in a statewide database.

Dead bird surveillance was another method used to monitor for WNV. Some bird species, such as chickens, do not become ill when infected with WNV nor do they accumulate enough of the virus in their systems to readily pass the virus back to mosquitoes. Raptors (e.g. hawks and owls) and Corvids (e.g. crows, ravens, magpies and jays) are especially susceptible to WNV and often sicken and die from the virus. This sensitivity and the fact that wild birds are in contact with mosquitoes far longer than most humans make their deaths a good leading indicator for potential human cases. To facilitate the reporting of dead birds on weekends and after normal working hours a dedicated "dead bird" phone line was established.

Citizen complaints and questions received via telephone, in person, or by email are treated as opportunities to provide education. Complaints are logged and ICHD usually responds with a personal visit which may include setting traps and/or dipping for larvae and distributing of brochures that suggested ways for individuals to protect themselves and reduce breeding habitat. An example of the complaint form used is provided in Figure 3 and brochures are available from ICHD in English and Spanish.

Figure 3. Mosquito Complaint Form

ISLAND COUNTY HEALTH DEPARTMENT
MOSQUITO COMPLAINT FORM

Date Received: _____

Location of Complaint: Plat: _____

Street Address City Zip

Brief Description of Complaint: _____

Area for drawing on reverse side

Tax Parcel # _____ **Key #** _____ Acres: _____

Owner of Record: _____ Phone # _____

Mailing Address City Zip

Property Management or Tenant: Phone #

Complainant Information: **Anonymity Requested:** **Yes** **No** **Initials:**

Information received by: _____ Telephone _____ Office Visit _____ Other: _____

Name: _____ Phone Number: _____

Address: _____
Street Address City Zip

Report of Investigation and Action Taken:

Date	Description	Initials

Background

Weather And Climate

Mosquito development and population dynamics are closely tied to weather. When and how much rain is received, wind speed and direction, maximum and minimum temperatures, and the total amount of heat energy accumulated are all critical to mosquito development.

The most significant factor affecting weather on Whidbey and Camano Islands is the moderating influence of Puget Sound. This affects the county as a region because the surrounding marine waters change temperature primarily as a function of depth and not geography. Another basic aspect of Island County weather results from being in the "rain shadow" on the lee side of the Olympic Mountains. Some of the moist, prevailing winds moving off the Pacific Ocean are deflected around the mountains and, in part, miss Island County. Air forced over the mountains loses much of its moisture on the journey up the west slopes but begins picking up moisture again as it comes down the east slopes. The air is still relatively dry when it arrives at the western-most portion of the county at central Whidbey Island but there is a pattern of increasing rainfall east across the county as one moves further out of the rain shadow.

Parts of Island County are also within the Puget Sound Convergence Zone where winds collide and mix between Seattle and central Whidbey Island. This results in a wide range of temperatures, rainfall and wind behavior. Weather data reported from any particular location on the islands is rarely typical of the entire county. For example, temperatures reported from Naval Air Station Whidbey Island (NASWI) are often considerably cooler than just 3 or 4 miles away in the town of Oak Harbor. A countywide network of volunteer-operated weather stations report rainfall and temperature data to the Island County Washington State University (WSU) Cooperative Extension office. The extension office compiles rainfall and temperature statistics and generates maps specific to Island County. Such information can be viewed at **http://www.island.wsu.edu/weather/weather.htm**.

Hydrogeology

The water (or lack thereof) in a habitat directly affects mosquito reproduction. All mosquitoes need standing water to complete their

development. Factors such as when it first collects in sufficient quantities, how long it persists, quality, depth profile, vegetation and predator species (often lacking in artificial containers) and geographical distribution all affect mosquito development. Different species variously exploit nearly all combinations of these factors.

The hydrogeologic characteristics of Island County vary widely. The primary parent material of most soils is moraine; the soil and rock carried here by glaciers and left behind as they melted away. The moraine varies from relatively well draining sand and gravel of the Hoypus and Everett soil series to the impermeable, cemented-clay hardpan of the Alderwood and Whidbey soil series. In many areas the glacially scoured bedrock is covered with only a thin layer of soil. Depressions in the landscape thus tend to collect and retain water from rainfall, runoff or seepage and results in the development of hydric soils that support a variety of wetland types. Ninety (90) watersheds have been defined on Whidbey Island and another forty (40) on Camano Island, all rain fed. They support a few perennial streams, additional intermittent streams, and many marsh areas that tend to be shallow and have reduced or no flow during the summer months. Generally smaller in scale, storm water ditches are subject to the same summer phenomenon. During the drought conditions of 2003 there remained pockets of standing water sufficient to breed mosquitoes throughout the county.

Basic Mosquito Biology

Mosquitoes are flies, in the order Diptera, as is the familiar housefly. Mosquitoes differ by having piercing-sucking mouthparts and scales on their wings, both of which may be seen with a hand lens. There are about 3000 species of mosquitoes worldwide, about 170 in North America, with about 50 of those in Washington State.

Like the majority of insects, mosquitoes have four (4) distinct life stages: egg, larva, pupa, and adult. Some mosquitoes lay their eggs on the water surface, either glued together in groups called rafts (*Anopheles*, *Coquillettidia*, and *Ochlerotatus*) or as multiple, single egg deposits (*Culex* and *Culiseta*). The eggs usually hatch within 48 hours. Others mosquitoes, so-called "floodwater" species (Aedes and Ochlerotatus), lay eggs in damp soil where the eggs can survive up to several years until flooded by rain or irrigation water, or by rising streams and marsh boundaries.

All mosquito larvae ("wrigglers") need standing water to complete their development, though a hoof print or tire track may be all that is required. Like many other insects, mosquito larvae utilize the relatively undisturbed surface tension of still waters and are not found in moving streams and rivers or open lakes and seas. To breathe, wrigglers rise to the surface and hang attached to the surface tension layer (at an angle characteristic of their species) with their siphon tubes pierced through to the atmosphere. Some genera (*Coquillettidia* and *Mansonia*) remain underwater and use their siphon tubes to penetrate air chambers of certain aquatic plants. *Anopheles* lack siphon tubes and lie parallel to the surface with bristles causing them to float with their spiracles (breathing openings) above the surface. Larvae feed on microorganisms and other organic matter in the water and in approximately 7-14 days, depending on temperature and species, develop through four (4) stages (instars) before entering the pupal stage.

Pupas ("tumblers") do not eat but, like larvae, require air to breathe. Bristles on the fat, comma-shaped body cause the pupa to float high enough for two modified siphon tubes (trumpets) protruding from the fused head and thorax to draw air directly from the atmosphere. When disturbed the pupa dive with a jerking, tumbling motion and then float back to the surface. They develop internally for about one (1) to four (4) days, at which time the back of the floating pupal case splits apart, allowing a fully developed adult mosquito to emerge.

The emergence is a critical process. The adult cannot fly until its exoskeleton and wings have dried and hardened and it is completely vulnerable to predators at this time. If the adult falls over into the water before the process is complete it will drown. If emergence is successful the adult may live between a few weeks and two (2) months, depending on conditions and species. Mosquitoes, depending on species, can also over-winter as fertilized, un-fed adults, as larvae in permanent water bodies, or as eggs.

History of Mosquito Complaint Responses

Island County has historically had and continues to have the occasionally severe nuisance problem with *Ochlerotatus dorsalis* (aka *Aedes dorsalis*), "salt marsh" mosquito. This mosquito is a major pest species associated with tidal pools and pastures prone to light flooding. On Whidbey Island the most impacted areas have been near Crockett Lake and Lake Hancock, while on Camano Island, Elger and Livingston Bays have generated the most complaint calls.

In 1990-1991 ICHD worked with Drainage District #6 (on Whidbey Island) to help identify and resolve a problem in the Crockett Lake area with *Ochlerotatus dorsalis*. The ICHD and WSU Cooperative Extension investigative team found that lake levels less than four feet, one inch (4' 1'') created many shallow pools. It was estimated that for every one (1) inch drop in lake level approximately ten (10) acres of breeding habitat suitable for *Ochlerotatus dorsalis* was created. The lake level was a controversial issue involving various political and private entities, questions of who would pay for resolution, recreational use claims, bird migration requirements, concerns over salt-water intrusion into wells, and the extreme numbers of mosquitoes attacking residents in the surrounding areas. An agreement was reached that the lake be maintained at a higher level, five feet to five feet six inches (5' - 5' 6") May-September to submerge mosquito habitat and be subsequently lowered during bird migrations. The District also agreed that a second tide gate be repaired and brought back into operation to increase tidal exchange to keep salinity levels high enough to prevent the return of a severe midge problem. The lake margins had larvicide applied that spring because the lake had not yet risen to the target level. ICHD and WSU Cooperative Extension office began a public education program about mosquito abatement strategies and methods.

In 1995 ICHD and WSU Cooperative Extension facilitated the creation of Island County Mosquito Control District 1 (ICMCD1), the first (and only) in the county and one (1) of only fifteen (15) in Washington State. When a dike broke in the Livingston Bay area on Camano Island in 1990 the sea reclaimed a tidal area that had previously been converted to farmland. The area was inundated with drift logs that remained trapped behind the majority of the dike still in place. *Ochlerotatus dorsalis* began to breed prolifically in the nearly ideal breeding habitat that was created. As in the Crockett Lake situation, the response was complicated by many factors. The problem not only affected the peace of mind of local residents but also the local economy. ICHD and WSU Cooperative Extension trained citizen volunteers and supervised a field investigation, recommended the formation of a citizen-voted Mosquito Control District and volunteered to help with the formation process. Because of the time involved in the formation of a District the county also agreed to help with the initial treatment of the most critical ten (10) acres of mosquito breeding habitat.

In July 2003 the Health Department partnered with the Public Works Solid Waste Division to raise public awareness of the connection between old tires and mosquitoes by organizing a weeklong used tire-

recycling event. Old tires are nearly ideal mosquito incubators, offering persistent standing water, high humidity, warm temperatures, and lack of large predators. Over the course of a warm summer an old tire can generate over 25,000 mosquitoes. Nearly forty percent of the total tires collected for the year were gathered during that single week.

History of Mosquito Surveillance in Island County

Washington State Department of Social and Health Services (DSHS) conducted the only comprehensive mosquito survey prior to 2000 (in the 1960's) in Island County. In response to WNV spreading so rapidly from New York since 1999, a grant was awarded to Washington State Department of Health (DOH) in 2000 to help establish routine mosquito-borne disease surveillance by state and local health departments. In 2002 ICHD received trapping kits and rearing containers from DOH and staff volunteers accomplished a brief, mosquito survey in Island County. Two mosquito species not previously identified in Island County were collected during this survey.

Island County received a grant in 2001 from CDC to build capacity in environmental health. A process called PACE-EH (Protocol for Assessing Community Excellence in Environmental Health) was selected as the method. The PACE-EH model provides a framework for communities to identify, assess, and address their local environmental health concerns. WNV was one of four environmental health concerns identified by the 26 citizen members appointed to the Environmental Health Assessment Team (EHAT) working on this project. Baseline data was needed for the citizens in the community group to make informed decisions about the issue of WNV. Through this community process and with funding provided by the CDC for data collection, ICHD was able to conduct a mosquito surveillance project in Island County from June through September of 2003.

In January 2003 ICHD presented a recommendation to the Board of County Commissioners to adopt a resolution to establish a county wide Mosquito Control District providing Island County voters an opportunity to consider the measure as soon as was practical. The recommendation was based upon the risks associated with WNV, the inability of Island County government to perform general mosquito abatement, and the need for a comprehensive mosquito abatement program. To date, a resolution has not been passed to place the issue on a ballot.

Materials and Methods

Materials

Five commercially manufactured CDC design traps with rechargeable Ni-Cad batteries providing 18-20 hours operation were used to capture adult mosquitoes. The dry ice used to bait the traps was purchased in 10-pound blocks from grocery stores. It was handled with insulated gloves, (dry ice is approximately –109ºF), transported in an insulated ice chest, and broken into smaller pieces for use with a 3-pound sledgehammer. A manual aspirator (mouth-operated suction device) allowed adults to be collected off of personnel and out of buildings and vehicles. Larvae were collected with a standard white plastic dipper, transported in lidded plastic containers, and reared to adult stage for identification in three (3) mosquito-rearing containers. A hand lens and specimen forceps aided in identifying and handling specimens. A handheld GPS receiver (Magellan *Meridian*) was used to gather and record spatial data electronically and a three-ring field binder was used to manually record data. A sample field data form is shown in Figure 4.

Methods

Specimen Sampling

There was not the budget to conduct a systematic grid survey. Therefore initial selection of sample sites were primarily based upon previous mosquito complaints. Complaints received during the course of the survey were also investigated. Some sample locations were chosen based on areas of human population concentrations, such as within city limits or in parks and recreation areas. Special consideration was given to areas where there were populations considered particularly at risk to WNV (those with immune system problems and people over age fifty) such as hospitals, retirement communities, nursing homes and other adult care facilities.

Other sample sites were chosen based on their potential to breed or harbor mosquitoes, beginning with previously mapped wetlands. Additional areas likely to harbor mosquitoes discovered during scouting and trapping activities were also investigated. These areas included unmapped wetlands, standing water in ditches and culverts, landscape ponds, persistent construction-site puddles and any other likely breeding or resting areas. Sample site selection also considered

the ease and practicality of setting and collecting traps and of obtaining permission from landowners to access private property. A general map of collection site locations is shown in Figure 5.

Adult mosquitoes are generally more easily differentiated by species than are larvae and were the primary collection focus. All mosquito trapping methods and the variables of their use (height and location of placement, type of attractants used, time of day, wind, etc.) bias the sex and species composition of the catch, and the total numbers captured. New Jersey light traps have traditionally been used but have been largely supplanted by the dry ice baited CDC design traps used in the ICHD mosquito survey. The CDC trap and its associated protocols is the accepted standard for the Washington State DOH (and for most other agencies). These traps attract far fewer non-mosquito species and bias the catch towards the blood-seeking females. The smaller, battery-powered CDC traps are more practical in temporary field locations and are easily set and moved in response to complaints. Some mosquito-trapping data, supplemental to that gathered directly by ICHD staff, was supplied by ICMCD1 from fixed trapping locations that are part of their existing surveillance program. Their traps are propane powered, semi-fixed units designed for yards and other large spaces.

A trapping schedule was designed to best account for local logistical constraints including dry ice availability, the limited numbers of traps, batteries, rearing containers in inventory, and the amount of staff-time available for the project. Dry ice was occasionally problematic to obtain when needed and could only be stored for short periods. Twice each week the traps were set in late afternoon. The traps operated throughout the night and were collected mid-morning the following day. In addition, many sample sites were visited more than once during the survey to better account for the different breeding cycles of various mosquito species.

Dipping was a useful adjunct to trapping and in some cases was used as the only means of sample collection. At some sites, setting a trap was problematic for various reasons, such as lack of something to hang it on, lack of permission by a landowner to leave it over night or concern about vandalism. Dipping provided a quick alternative, though the specimens then had to be cared for until the adults emerged. Importantly, those adults could then be positively correlated with an area of origin whereas trapped adults could have originated many miles away. Also important to a surveillance program is that the appearance of larvae in large numbers precedes an outbreak of adults.

An aspirator was carried during scouting and collecting activities and was a useful tool. At sample sites where traps were retrieved empty there would occasionally be a few mosquitoes observed flying in the area and mosquitoes disturbed from resting sites would sometimes land on technicians. Aspirating allowed capture of a few specimens for identification in those circumstances.

Specimen Management

There was usually a small amount of dry ice remaining in the traps at collection time, which was placed in the ice chest with the containers of captured adult specimens. The carbon dioxide anesthetized (and eventually killed) the specimens, preventing self-inflicted damage that would interfere with identification. Larvae were transported with water in plastic containers. Before transferring the larvae to rearing containers the batches were examined for non-mosquito species, some of which are predators. Non-mosquito specimens from traps were also discarded. Adult mosquitoes specimens were packed between sheets of tissue paper in petri dishes to keep them dry and to protect them from mold and physical damage during shipping and storage.

All dead birds reports were documented. ICHD staff collected birds that met criteria for laboratory analysis (freshly dead Raptors and Corvids in good physical condition, etc.). The specimens were handled, documented, stored, and shipped according to DOH protocols. The samples were sent to Washington Animal Disease Diagnostic Laboratory at Washington State University in Pullman, Washington.

Data Management

Each petri dish of specimens was marked with the local ID associated with that batch from the time of collection. Each alphanumeric local ID begins with a letter prefix: WN (north Whidbey), WC (central Whidbey), WS (south Whidbey), or C (Camano). The next digit, in this case the number 3, represented the year 2003. The following four (4) digits were the two-digit month and two-digit day of collection. The last digit of the ID, typically a number 1-6, represents a particular sample event that day. A local ID number thus provided a unique identifier for each specimen batch as well as other easily discerned information useful in managing specimen data. The marked specimens were shipped to DOH in Olympia with other identifying information for official identification to species and documentation in a statewide database. A sample data form for DOH is shown in Figure 6.

At each sample site latitude and longitude coordinates and certain other identifying data were gathered and recorded electronically with a

GPS receiver. The receiver needs to "see" an adequate number and distribution of satellites to accurately determine location. That was not always possible due to tree cover or some geologic or architectural feature partially blocking the receiver's view of the sky. The number of satellites visible to the receiver also varies by time of day and year. There may be as many as 8-10 distributed across the sky or perhaps only 4 clustered near the horizon.

Maps were created from project data but exact locations may not be displayed due to the satellite triangulation problems mentioned above and because of problems of scale when reducing maps to page size. For instance, locations where multiple sample events took place or sample sites that are geographically close together are shown slightly offset from one another to be more visually apparent. Most of the sites indicated are trapping sites and do not necessarily correlate directly with active breeding areas because adults fly (sometimes large distances) from where they emerge.

Contact names and addresses (when possible), local place names with other descriptions and general information, and GPS data were recorded manually on rainproof paper held in a 3-ring binder. The page design allowed for recording multiple trapping methods used during a single collection event and for correlating two (2) collection events at a single location on different dates. Data from the GPS receiver was uploaded electronically directly into a Microsoft Access database and information from the field book transferred manually.

Figure 4. Field Data Form

Contact Name:	
Phone:	
Address:	
Email:	Locality Name:

Collection Type/Time:	Sample Number:	Weather Note:	First Date:
Trap			
Dip	GPS Coordinates:		
Net		Habitat Description:	
Aspirate			
Collection Type/Time:	Sample Number:		
Trap			
Dip	GPS Coordinates:		
Net			
Aspirate			

Collection Type/Time:	Sample Number:	Weather Note:	Second Date:
Trap:			
Dip:	GPS Coordinates:		
Net:		Habitat Description:	
Aspirate:			
Collection Type/Time:	Sample Number:		
Trap			
Dip	GPS Coordinates:		
Net			
Aspirate			
Notes and Observations:			

Figure 5. Locations of Survey Sample Sites

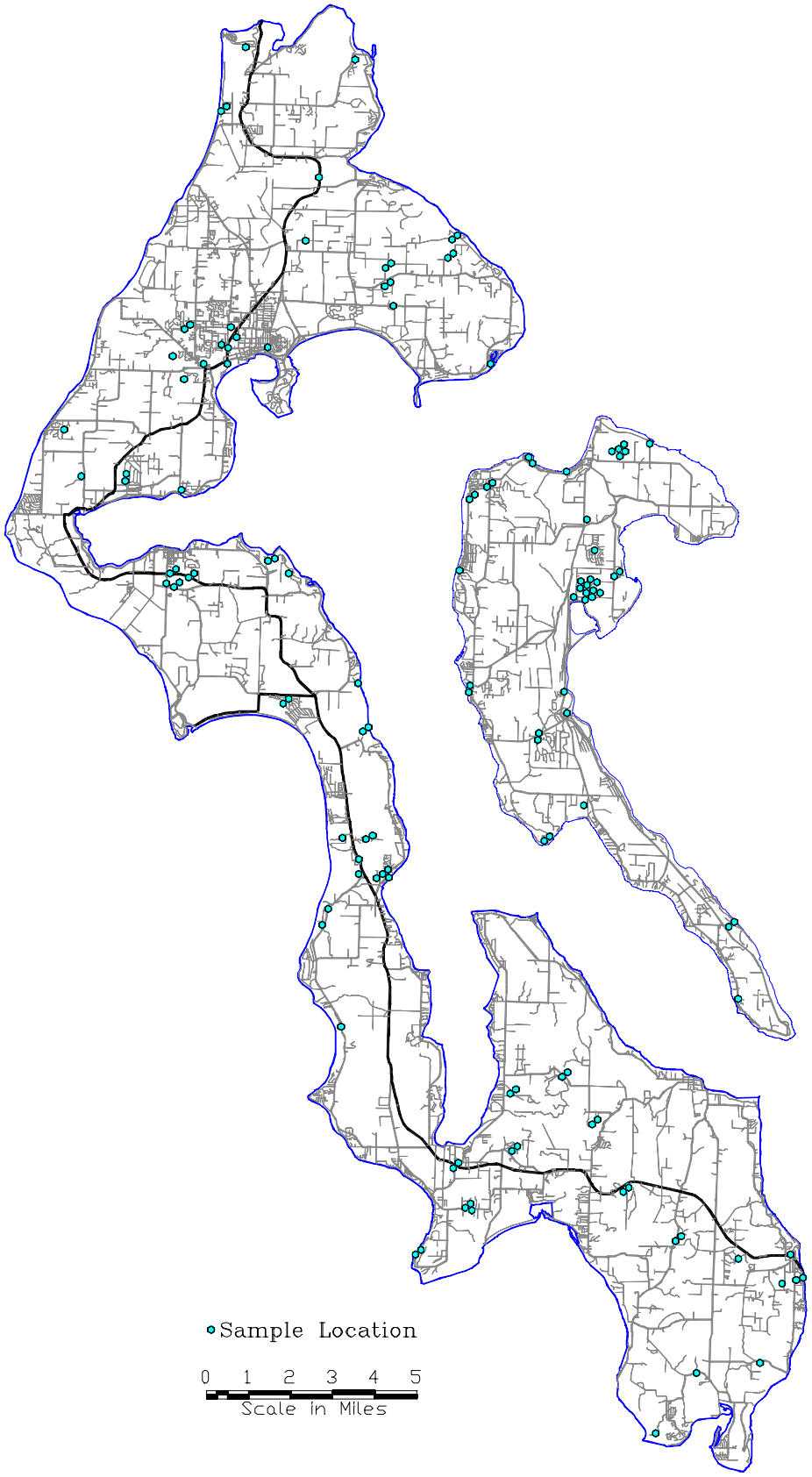


Figure 6. DOH Data

Trap Location

Location Name
_____

Physical Address
_____

Address
_____

City/State_____

_____

County_____

Zip
Code_____

GPS Coordinates
Latitude (i.e., 47.198062)

_____

Longitude (i.e., 122.386037)

_____

(Please report your GPS coordinate in decimal degrees with a minimum of six decimal places.)

Location Description
_____

_____

Collection Date _____/____/____

Length of Trapping Time _____

Trap Type

Carbon Dioxide Light Dip
Gravid Oviposit
Other _____

Number of traps for this type _____

Collecting Agency

Name_____

Address_____

_____

City/State/Zip_____

_____

Contact
Person_____

Phone_____

Fax
_____

Email
_____

Reporter Name

Name_____

Comments
_____

_____

_____

_____

Local ID _____

Other ID_____

Results and Discussion

There were many opportunities for public education and outreach during the project. Citizens were interested in trapping and dipping activities and concerned about WNV. They were receptive to discussion and brochures about mosquitoes and WNV.

Table 3 (page 24) lists the mosquito species previously documented in Island County and those observed during the 2003 survey. The species shaded in gray are considered potential WNV vectors. Examples of all six (6) genera found in Washington State, *Aedes*, *Anopheles*, *Culex*, *Culiseta*, *Coquillettidia*, and *Ochlerotatus*, were found in Island County during the survey of 2003. Eighteen species were collected, five (5) of which had not previously been documented in the county. They are *Aedes vexans*, *Culex tarsalis*, *Culiseta minnesotae*, *Ochlerotatus melanimon*, and *Ochlerotatus sierrensis*. Two of these, *Aedes vexans* and *Culex tarsalis*, are considered potential WNV vector species.

Six (6) species observed in Island County prior to 2003 were not present during this survey. They are *Aedes cinereus*, *Anopheles freeborni*, *Culiseta impatiens*, *Ochlerotatus excrusians*, *Ochlerotatus punctor*, and *Ochlerotatus stickticus*. Reasons for this may include the large increase in human population encroaching on mosquito habitat, a drier than usual 2003 season, the small sample size, or simply that natural ecological dynamics are, indeed, dynamic. There is also little known of the original statewide survey in the 1960's or its protocols.

Between mid-June and September 30th there were 140 collection events (i.e. trapping, dipping, etc) distributed over 17 days. Twenty-one of the 140 sample sites administered by ICHD (15%) were visited more than once. As shown in Table 1 three (14%) of those multiple visits showed no change in species composition while 18 (86%) showed a change. Approximately half of those showing a change had more species present (12) and half (13) had less. One third (7) of the total multiple visits showed both the appearance of some species and the disappearance of others.

Table 1. Species Composition Observed Over Multiple Visits

Multiple visits with **no change** in species composition (3/21 sites)	**14%**
Multiple visits with a **change** in species composition (18/21 sites)	**86%**
Of those sites showing change (18 sites) percent **increase** in species	**57%**
Of those sites showing change (18 sites) percent **decrease** in species	**73%**

The previous numbers and percentages concerning multiple visits excludes data supplied by Island County Mosquito Control District 1 (ICMCD1), whose sites were all visited multiple times as part of their surveillance program. ICMCD1 sites were those shown clustered in north and east-central Camano Island (Figure 5).

Some sample events did not yield any mosquitoes. Some of the "none found" trapping events took place in locations of special interest, such as Adult Family Homes, where there were no obvious breeding or resting areas nearby. Other unsuccessful trapping events were associated with variables not specifically identified by project staff. No mosquitoes were captured during 33% (46/140) of sample events. The exceptionally dry summer of 2003 appears to correlate with frequency of collecting empty traps. The "none found" percentage varied by month; in June it was only 2% of the sample total for that month, in July slightly higher at 6%, in August up to 65% and in September back down to 26% (See Table 2).

Table 2. Percent of Trapping Events Yielding No Mosquitoes

June	July	August	September
2%	**6%**	**65%**	**26%**

The distribution of potential WNV vector species is shown in Figure 4. There appears to be a slightly higher incidence of *Culiseta inornata* across the central portion of the county, especially on Camano Island. Camano also had a noticeably higher incidence of *Coquillettidia perturbans* than did Whidbey Island. More *Culex pipiens* showed up on Whidbey than Camano and were found predominantly in areas of increased human concentrations, i.e. Oak Harbor, Coupeville, Freeland, and Clinton.

Species other than those shaded species in Table 3 have been successfully inoculated with the virus in the laboratory, that is, the virus did not immediately cease to function when introduced into test mosquitoes, but more than this is required for a species to effectively vector the virus in the wild. A mosquito's physiology and behavior must be conducive to maintaining the bird/mosquito transmission cycle. Infected mosquitoes may transfer the virus to incidental hosts (humans, horses and others) because species such as *Culex tarsalis* readily bite both birds and mammals.

The 2003 mosquito season was anomalous in that, according to the Office of the Washington State Climatologist, the summer was one of the warmest of record and was the driest in over 100 years. Many lakes and wetlands were the lowest or driest in living memory.

Specifically how these drought conditions affected mosquito population dynamics is a matter for speculation but a wetter, more typical season would likely show different survey results.

We will not know which species will transmit WNV in Washington until the virus actually arrives and surveillance results begin to be analyzed. The most likely WNV vectors will be those in the *Culex* genus, in particular, *Culex tarsalis* and *Culex pipiens* (northern house mosquito). Both are ubiquitous in the environment, feed on birds and mammals (including humans), and breed throughout spring and fall in almost anything retaining even a small amount of water for approximately a week. Breeding sites include old tires, tire tracks and other puddles, poorly draining rain gutters, birdbaths, jars, and other water-trapping junk. *Culex tarsalis* are strong flyers, potentially reaching most areas in the county from their habitat of origin and breed in artificial containers and natural settings. *Culex pipiens* seldom fly farther than ½ mile from their breeding sites and prefer the non-natural bird baths and bucket type habitats associated with areas of human habitation. They also readily enter homes and buildings.

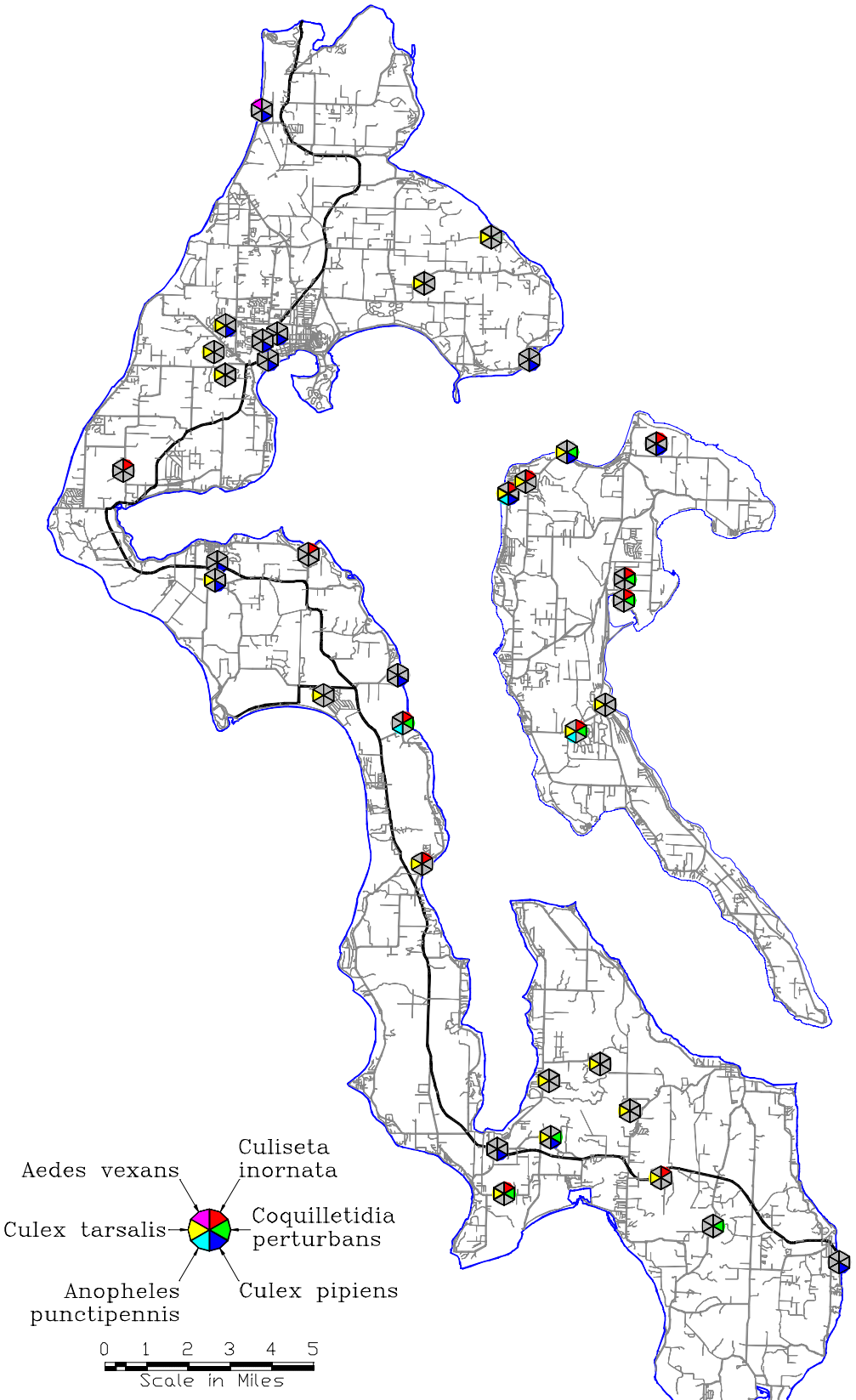
As seen in Figure 7, *Culex pipiens* is predominantly associated with human population centers and could potentially affect large numbers of people. An example of such an outbreak occurred in Oak Harbor during the 2003 survey. A mosquito nuisance complaint was received from an Oak Harbor resident, with the homeowner reporting large numbers of mosquitoes appearing suddenly. There was no rainfall event prior to the complaint and a natural wetland in the area was still dry. Traps were set twice and on both occasions captured large numbers of two (2) potential vector species, *Culex tarsalis* and *Culex pipiens* (the large majority). Due to both species' proclivity for breeding in artificial containers and the small flight range typical of *Culex pipiens*, a neighborhood-scale habitat-reduction effort could make a difference and such efforts could be a vital part of an overall community response.

The arrival of cold weather and winter means the end of mosquito and dead bird surveillance for the season. Washington State DOH suspended lab tests of dead birds and ICHD suspended documentation of dead bird reports on October 31, 2003. There were 208 dead birds reported to ICHD during the 2003 survey, nearly all crows. Forty-four (44) crows, two (2) owls, and one (1) red-tailed hawk met testing criteria and were sent in for viral testing. All were shown to be free of WNV.

Table 3. Mosquitoes Identified in Island County

NOTE: Shaded areas denote potential WNV vector species in Island County.	Potential WNV vectors	Identified 2002 and prior	Identified during 2003	COMMENTS
Aedes cinereus	X	X		
Aedes vexans	X		X	Not observed prior to 2003
Anopheles freeborni		X		
Anopheles punctipennis	X	X	X	
Coquillettidia perturbans	X	X	X	
Culex pipiens	X	X	X	
Culex restuans		X	X	
Culex tarsalis	X		X	Not observed prior to 2003
Culex territans		X	X	
Culiseta particeps		X	X	
Culiseta impatiens		X		
Culiseta incidens		X	X	
Culiseta inornata	X	X	X	
Culiseta minnesotae			X	Not observed prior to 2003
Culiseta morsitans		X	X	
Ochlerotatus aboriginis		X	X	
Ochlerotatus campestris		X		
Ochlerotatus dorsalis		X	X	
Ochlerotatus excrusians		X		
Ochlerotatus increpitus		X	X	
Ochlerotatus fitchii		X	X	
Ochlerotatus punctor		X		
Ochlerotatus melanimon			X	Not observed prior to 2003
Ochlerotatus sierrensis			X	Not observed prior to 2003
Ochlerotatus stickticus		X		

Figure 7. Locations of Samples Containing Potential WNV Vectors



Recommendations

Goals of the survey project were to establish a foundation on which future efforts could be based and to establish a baseline of data and procedural knowledge that would contribute to the success of a surveillance program. The following recommendations are based on the experience gained during the 2003 survey. They are divided into those that address the procedural aspects and those addressing basic program considerations.

Procedural recommendations:

- *Start earlier in season*: Knowing when, where and which species first emerge provides planners with important information concerning the upcoming season.
- *Establish permanent, strategic trap locations*: Now that an initial survey has been accomplished future surveillance activities will provide extremely useful historical information to guide public health planning and response decisions.
- *Establish a series of semi-permanent traps on fixed routes*: Fixed routes could be serviced and checked efficiently, providing more information for staff-time spent. The portable CDC traps presently in inventory could then be used for temporary, shifting-focus placement.
- *Systematic sampling of retention and detention ponds*. These ponds are often located in public view and perceived as mosquito-breeding areas. It should be factually determined if they provide significant mosquito breeding opportunities. This may require obtaining permission to access private ponds and keys to access fenced and locked Washington State Department of Transportation (WSDOT) retention and detention facilities.
- *Systematic sampling of storm water catch basins and vaults*: The basins are mainly located within populated areas. During a wetter, more typical season they can attract the northern house mosquito, *Culex pipiens*, which is considered one of the primary potential vectors of WNV. It should be determined if active breeding populations are found in these areas.
- *Integrate a greater variety of collection techniques*: This would include CDC traps, gravid traps (very good for attracting female *Culex pipiens*, an important potential WNV vector), dipping,

rearing, netting, and aspirating. Overall collection bias would be reduced and deliver mosquitoes for identification more reliably.

- *Additional rearing containers*: Each container is dedicated to a batch until the adults emerge and the three (3) rearing containers presently in inventory were insufficient. Dipping and rearing could be an integral part of the collection program, particularly for semi-permanent sites such as retention and detention ponds.
- *Modify field data forms*: Add "none found" and "some found" entries that would be circled to indicate whether mosquitoes were found; add a "WPT" (way point) entry to manually record the numerical designator generated by the GPS receiver. This number is important in tracking entries in the database.
- *Encourage the participation of community organizations*: An interested lay public could be of help in a survey or surveillance effort. For example, groups such as 4H or Scouts could be encouraged to find possible mosquito breeding habitat and trained to dip and raise larvae to the adult stage for identification.

Program recommendations:

- *Establish a "communication and cooperation" protocol*: To best minimize risk of WNV transmission to humans and domestic animals will require a coordinated response that integrates resources, expertise and effort between pertinent programs, departments and jurisdictions such as county, city, WSU extension, Conservation Districts, etc.
- *Increase public outreach and education*: Citizens are interested in what is being done about WNV. People encountered during field sampling and scouting activities were readily engaged in conversation. They are curious and supportive of the effort to find out more about WNV and whether there is a danger. This is an opportunity for surveillance personnel, knowledgeable about mosquitoes and WNV and aware of local problem areas, to inform and reassure concerned citizens. Department approved public speaking engagements would also utilize this expertise.
- *Establish mosquito control district(s):* ICHD continues to recommend the formation of a mosquito control district for Island County. Individual property owners must accept personal responsibility for assuring that mosquito habitat is minimized on his or her own property but individuals cannot accomplish the necessary regional abatement tasks that are necessary if the issue of mosquitoes and WNV is to be effectively addressed.

References

California State Department of Health, Vector and Waste Management. 1975. A Training manual for California Mosquito Control Agencies. CMCA Press, Visalia, California.

Contra Costa Mosquito and Vector Control district, Comparative Biology of Twenty-One Prevalent California Mosquito Species 155 Mason Circle, Concord, California 94520
http://www.ccmvcd.dst.ca.us/mosquitoes.htm

Epidemic/Epizootic West Nile Virus in the United States: Revised Guidelines for Surveillance, Prevention, and Control, from a workshop held in Charlotte, North Carolina, Jan 31-February 4, 2001

Pratt HD, Moore CG, 1993. Mosquitoes of Public Health Importance and Their Control. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, Public Health Practice Program Office. Atlanta, Georgia.

Washington State Department of Health, November 2002. Mosquito-borne Disease Response Plan. Olympia, Washington.

Appendix A. Biology of Potential WNV Vectors in Washington State

The following mosquitoes, collected in Island County during the 2003 mosquito survey project, have been previously implicated as potential vectors of WNV in other parts of the United States. They are not equally competent as vectors and only after WNV arrives in Washington and Island County will we be able to determine which of these species, or others, will pose the greatest public health risk.

Some of the data presented below are not entirely objective. Mosquito data is still somewhat scarce and sometimes estimations are made based on limited observation. Flight ranges listed are normal-range estimates but wind can increase or decrease the range drastically. The following has been adapted from Washington State DOH information.

Culex pipiens (northern house mosquito)**:** This species is medium-sized, brownish with pale bands around the abdominal segments. It is endemic in most counties of Washington. The quickly developing larvae may be continuously present spring through fall. Although they occur in rural environments, they reach their greatest numbers in urban and suburban areas and readily enter homes. *Culex pipiens* are known to vector St. Lewis encephalitis (SLE).
Larval habitat**:** Nearly anything retaining water, clean or polluted—artificial containers, catch basins, ground pools, animal waste lagoons, tires, hoof prints, etc.
Biting time**:** Night
Preferred host: Mostly birds, but will readily bite mammals, including humans
Flight range**:** ¼ to ½ mile from breeding site

Culex tarsalis: This is medium-sized, dark mosquito that has a broad white band across the middle of the proboscis and the lower leg segments. It is endemic in nearly all counties of Washington. In addition to being a potential vector of WNV this species is the most important vector of Western Equine encephalitis (WEE) and SLE.
Larval habitat**:** Nearly anything retaining water (see *Culex pipiens*)
Biting time**:** Most active at nightfall but also through until daylight
Preferred host**:** Mostly birds, but will readily bite mammals, including humans
Flight range**:** 5-15 miles

Aedes vexans (inland floodwater mosquito)**:** This is a medium sized brown mosquito with v-shaped notches in the upper abdomen scales. It is one of the most common floodwater mosquitoes and a reported problem species in most states. They are vicious biters and can harbor many viruses including SLE, WEE, eastern equine encephalitis (EEE), and La Crosse encephalitis (LAC), in addition to WNV. Eggs are laid in mud and hatch when flooded in the spring or early summer. Several hatches may occur each season as water levels recede and rise, however the eggs can remain viable for several years if flooding does not occur.
Larval habitat: Floodwaters, irrigated pastures and other grassland pools
Biting time: dusk through dawn
Preferred host: Birds and mammals
Flight range: 5 to 15 miles from breeding site

Anopheles punctipennis: The wings have conspicuous pale and dark spots and palpi that are entirely dark. They are aggressive biters and readily enter homes.
Larval habitat: Woodland pools containing vegetation and in artificial containers and other environments associated with Culex tarsalis and Culex pipiens.
Biting time: Day and dusk
Preferred host: large mammals including cows, horses, and human
Flight range: 0 to ¼ mile from breeding site

Coquillettidia perturbans**:** This species is rather large, speckled brown and pale colored and has characteristic pale bands at the lower thirds of the hind leg segments. They are aggressive biters and readily enter homes. Larvae are unusually slow to develop and spend the entire development through pupa underwater. They are found attached to stalks of vegetation and do not need to rise to the surface to breath.
Larval habitat: Cattails marshes and in thick growth at edges of ponds, lakes and ditches
Biting time: Day and dusk
Preferred host: Mammals, including humans
Flight range: 1-5 miles from breeding site

Culiseta inornata (snow mosquito): This species also rather large, grayish-brown with broad, pale-scaled wings. The fertilized females hibernate in winter and emerge during warm spells, even

when snow is still on the ground. It continues to breed throughout spring and summer. Known to vector WEE and is implicated in WNV.
Larval habitat: often in cold, fairly clean water
Biting time: Dusk through dawn, temperature influenced
Preferred host: wild and domestic mammals, usually not humans
***Flight range*:** unknown